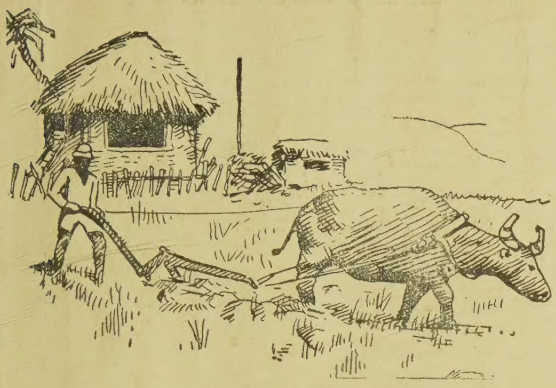
The Philippine Agriculturist and Forester



Vol. I March, 1911 No. 3

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CONTENTS

	Page
Caingin	43
Physiology of the Coconut	44
Plant Doctors	51
Reforestation	53
Live-stock farming & Soils	54
Agricultural Conferences (Editorial)	56
Coconut Cultivation	57
Conferences of the Bureau of Agriculture	61

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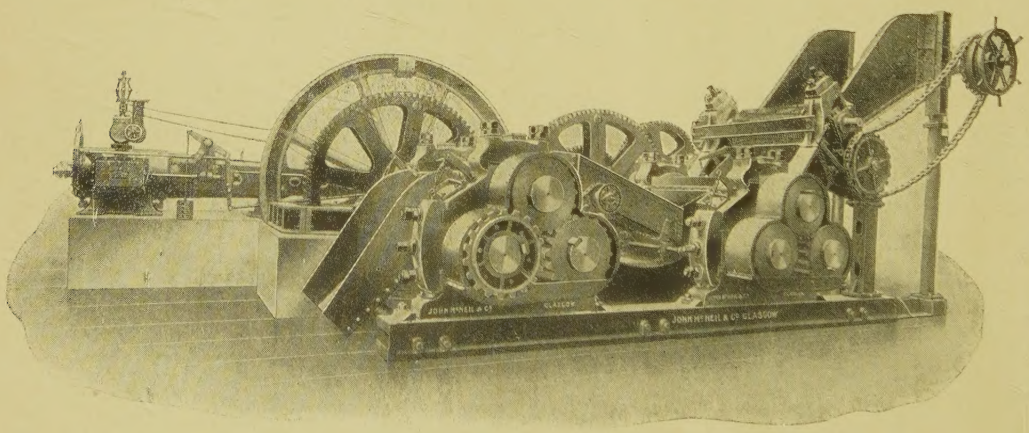

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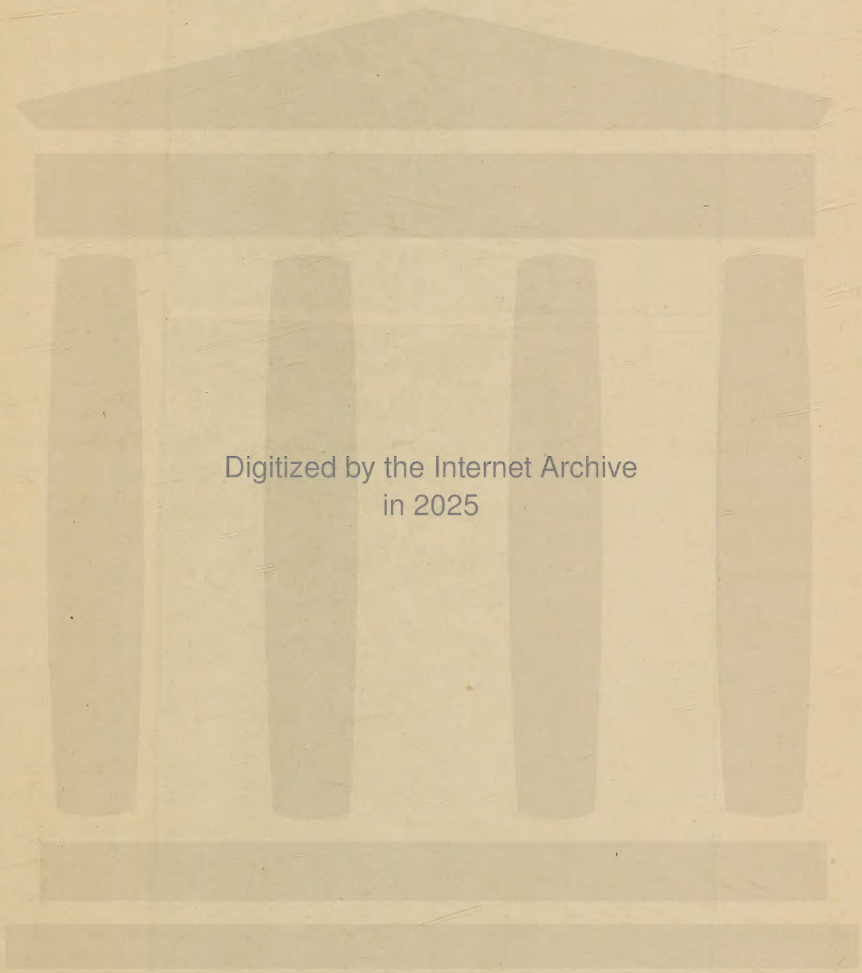

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MAIZE ON VIRGIN SOIL AND ON COGON *(See article on opposite page.)*

THE PHILIPPINE AGRICULTURIST AND FORESTER

Vol. I. MARCH, 1911 No. 3

CAINGINS

By general consent, Philippine agriculture is under a curse. General consent is not proof, and in this case a good argument can be made against it. But assuming that the curse is real, there are three candidates for the place—ignorance, lack of draft animals, and the caingin. The caiñgin is land cleared of woody vegetation and used for crops. After producing two or three crops, or sometimes only one, it is abandoned. This system of agriculture is common throughout the eastern tropics, and at least in parts of the New World as well. It is very popular with poor people who like to be their own masters, and in great disfavor with the state.

The inducement to make caiñgins is well illustrated by the cut on the opposite page. The caiñgin is comparatively free of troublesome weeds, and is exceedingly fertile. The streak of very thrifty maize in the picture was a hedge; the remainder of the field on both sides was chiefly occupied by cogon. In the Philippines, these hedges gradually widen, sometimes to as much as ten meters; then they are cleared, and present in large measure the advantages of real caiñgins.

After a time weeds enter the caiñgin, the ground packs, the temporary exuberance of fertility wears out, and it becomes easier, with the implements available, to secure a given yield by clearing a new plot. The old clearing goes back to forest almost immediately if it is in the forest, but to grass first if there is brush and grass land about it. Here enters the interest of the State. In the Philippines it is in the interest of the State to have all, or nearly all, of the good agricultural land in permanent agricultural use. But the forest wealth is the wealth of the whole people, and the whole people cannot afford to have the forest sacrificed for the sake of a couple of crops. It takes many years for the forest on a caiñgin to become valuable again.

Still, the best thing about an abandoned caiñgin is the chance that it will return to forest. If it is occupied at first by grass *and there are no fires*, brush will smother the grass in a few years, and trees will in turn smother the brush, quickly or slowly according to the nearness of seed-bearing trees. If there are fires, they will kill most kinds of brush, but will not injure the cogon. As the result of fire, following caiñgins—for fire rarely hurts the tropical forest at all,—there are great grass areas in the Philippines. And these grass lands not only do not constitute any wealth at all for the people, but they injure the neighboring cultivated land in several ways.

In the first place, forests the world over serve to conserve and regulate the water supply. In a study of conditions in four Wisconsin towns, F. A. Shriner and the writer showed a decade ago that a decrease in the forest from 27% of the area to 6% resulted in the drying up of 65.5 miles of creeks, and a decrease to about one-third in the flow of water. The rest of the water escapes in floods, doing damage instead of being useful. In the last number of this magazine mention was made of aridity in Mexico, resulting from deforestation. The floods of Tarlac and Pampanga have the same cause. The forest is a protection against wind and dry air, as well as against floods and dry creeks.

And then there are the locusts. They do not breed in cultivated land, and they do not breed in the forest. But so long as men make and leave waste land which is not forest and not in cultivation, we need not hope to be without them.

E. B. C.

PHYSIOLOGY OF THE COCONUT

By E. B. Copeland

The entire course of study of the College of Agriculture is planned with the understanding that any science of crop production must be built on a knowledge of the physiology and pathology of the crops, and that without such knowledge there can be no science of agriculture. As the course is now organized, students entering the coconut class have had successively a year of general botany, a year of plant physiology, and a year of general agronomy, with especial attention to the grains; they have also had one year of chemistry, and take a second year while studying the coconut. They are obviously well prepared to study effectively so much of the physiology of a crop as does not require distinctly organic chemistry. And there is no crop, at any rate in this part of the world, which is so well known that such work as they are called upon to do will not add materially and practically to our knowledge of it.

The best general and easily used index to the condition of a plant is its rate of growth. It is certainly possible to develop such a knowledge of the growth of any plant, and of the reaction of the growth to outside conditions, that it shall be possible to make roughly such allowances as are necessary for temporary conditions (the weather), and to decide from one day's measurement of the growth that the plant's condition is poor, fair or good; that is, that the more fixed conditions (soil, climate, state of cultivation, freedom from living enemies) are or are not what they should be. The great value of such knowledge must be clear.

The only past study of the physiology of the vegetative coconut was published by the writer in the first number of the Philippine Journal of Science (1906, pp. 6-57). That study was made in one place, San Ramon near Zamboanga, and during a single exceptionally dry season. Even though it was done with reasonable thoroughness, at the time and place, it by no means furnished the data necessary for the establishment of standards by which the activity of coconuts in general can be judged. Neither do the data reported here suffice, but they are a very material contribution. For this place and season, they can be accepted with entire confidence, for they are selected represented representatives from a large mass of tables of results.

The coconuts of the college are none of them on land well suited to this crop. The soil, varying from forty centimeters to hardly more than a meter in depth, is everywhere too shallow. The depth mentioned includes the clayey, not sharply distinguished subsoil, which in turn rests on a succession of thin layers of volcanic tuff, such as, occurring in thick strata, is known as Meycauayan stone or "dobe stone." These groves are moreover so situated that they receive no ground drainage from Mount Maquiling. As Los Baños has a decidedly dry season, usually of several months duration, this soil becomes dry to a degree incompatible with very successful coconut culture without irrigation.

THE ROOT.

In my work at San Ramon, the most rapid growth observed for any root was 3.5 mm. per diem; but this was transitory, and greatest growth per mensem was less than 5 cm. The growth was usually very irregular. This has been the experience here as well; but some roots have come under observation which were growing more regularly fast. For example, the following table shows the growth of two roots measured by F. Cevallos. The figures in each case represent the growth during the preceding period, usually of one week.

Table I.

		A	B
October	20	13.0	15.55
	28	16.5	19.80
Nov.	5	23.2	19.10
	13	24.0	22.20
	20	26.9	16.70
	27	23.0	24.90
Dec.	4	26.2	24.80
	11	29.5	26.95
	18	25.7	24.55

It happens that the first of these roots grew in fertilized ground, and the second did not. The fertilizer was applied during the second week of September. There is a very slight difference in favor of the fertilized tree. However, the difference observed was not always in this direction; and considering the general irregularity in the rate of growth of roots, we are not at present justified in drawing any conclusions as to the influence of fertilization on their growth.

As the dry season advances, the growth of roots becomes slower, just as was the case at San Ramon; but the checking is up to this time nothing like so complete as was observed there. It naturally occurs first where the soil is thinnest. The row of trees under observation by A. Lejano is on shallower soil than that of Cevallos. The average daily growth of the roots of

Lejano's trees during the fall months, was more than 2 mm.; but the average daily growth of four roots from Feb. 2 to Feb. 16 was only 1.25 mm. The average daily growth of two roots measured by Cevallos from Jan. 14 to Feb. 18 was still 3 mm.

The most rapid steady growth reported for any root was 108 mm. from Oct. 31 to Nov. 26, covering eight measurements. This was one of T. Vibar's. During the first 19 days of February, his most active roots grew 31 and 30 mm. respectively; his trees are intermediate between those of Cevallos and Lejano. This relation between the depth of the soil and the ability of the tree to resist the evil influence of drought, is very instructive.

It is a good general rule, but naturally not without exceptions, that the larger the root the more rapid its growth. In the saturated atmosphere of a buried bottle, roots grow at about the same rate as in the soil; but the roots growing in free air, where the new roots of grown trees frequently emerge from the trunk, grow very slowly until they enter the ground.

The Leaf.

My work on the growth of leaves at San Ramon was very inadequate, because undertaken some time after the beginning of a severe drought, and confined to young trees. As the growth of the leaves is the most convenient criterion by which the activity of a tree can be determined at any one time, and as it stands in a double direct relation to the prospective productivity of the tree, we have here studied it with especial care and thoroughness. The following tabulation of the determinations of the growth of four of the trees measured by Vibar will give a good idea of the general rate. These trees are about ten years old, and are coming into bearing. The figures in each case represent millimeters of growth since the preceding measurement.

Measurements can of course be made only of the growth of the visible leaves. The method employed was as follows: A horizontal straight line of India ink is drawn across the youngest leaf, as low down as possible, and carried without a break onto the next youngest leaf. On the lowest possible part of the latter a similar mark is made, and carried onto the next older. The same is done on the lowest visible part of the succeeding leaves. Where there is no growth, these marks, each drawn on two leaves, will remain unbroken. This would also happen if the two leaves grew equally; but in normal growth the younger of any two visible leaves usually grows the more rapidly. The vertical distance between the two parts of the broken line is then the difference in growth. The break in the lowest broken line is the growth of the oldest growing leaf. The growth of the second oldest growing leaf is found by adding the break on the line at its base to the break in the line below. And the growth of each of the younger leaves is found by adding the break in the line on its base to the sum of the increments in length of the older leaves. Subsequent determinations are made by subtraction, without the use of new marks, except when younger leaves make their appearance.

This general method is the only easy and accurate one possible, in working on subjects of such size as the coconut tree. In detail, it can be modified as convenience suggests: for instance, it is sometimes simpler to draw a horizontal line across several leaves. As the growth of the leaves is entirely basal, no error is introduced by marking one part rather than another, so long as the power to make accurate measurements is not interfered with.

Vibar's results, shown in Table II show the most rapid growth observed at any time, 205 mm. in 3 days, by tree D; but this rate was closely approached at the same time by many trees. The youngest leaf always grows the most rapidly, or is sometimes equalled in rate for a time by the next older. Independently of the environment, the rate is decidedly irregular, as is unmistakably shown by comparing different leaves on the same tree. It happens fairly frequently that one leaf increases its rate while another decreases it; and this change is not rarely in the opposite direction to that which can be explained by a consideration of their grand periods of growth.

The real explanation, I believe, of most of these irregularities is to be found in the high tensions between the neighboring leaves. The latter are packed closely together, and, growing at unequal rates, must move along each other with considerable friction, and set up tensions whose occasional release will make the growth evidently jerky. These tensions are probably responsible for the equal elongation usually exhibited for a longer or shorter time by the two youngest leaves. The tendency is certainly for the younger leaf to grow the more rapidly, but the difference is not great enough to prevent their holding fast, one to the other, sometimes for a term running into weeks.

TABLE II.

Growth of Leaves, Beginning October 11.

	Leaf	Tree A. 1	0	1	2	3	4	5	Tree B. 1	0	1	2	3	4
Oct.	12	..	..	20	20	..	..	..	..	..	17	14	..	..
	15	..	..	66	59	7	2	..	..	..	60	46	3	..
	17	..	..	56	60	2	1	..	..	..	39	26	1	..
	19	..	..	62	49	5	4	..	..	..	49	28	1	..
	23	..	..	84	47	6	3	..	..	..	72	43	2	..
	26	..	..	80	55	12	2	2	..	..	60	35	5	3
	31	..	..	122	120	14	4	4	..	..	100	56	6	3
Nov.	4	..	..	80	68	4	4	..	..	..	90	22	6	4
	7	..	..	80	35	3	7	..	..	..	73	18	6	2
	10	..	..	86	15	5	2	..	..	..	50	14	3	1
	13	..	..	90	16	6	2	..	..	..	78	15	4	1
	16	..	..	86	15	7	1	..	..	shows	79	17	3	2
	19	..	..	76	12	2	..	..	..	78	78	16	5	..
	22	..	..	80	15	6	1	..	..	66	66	17	4	..
	26	..	..	82	15	4	1	..	..	69	69	20	6	..
	30	..	shows	87	28	3	2	..	..	71	71	30	5	..
Dec.	4	..	96	96	31	4	..	..	..	103	83	29	4	..
	11	..	232	175	66	8	..	..	..	180	160	63	12	..
	24	..	117	92	42	6	..	..	shows	140	122	42	8	..
Jan.	3	shows	127	81	31	4	..	..	113	106	92	32	6	..
	10	146	146	56	29	..	..	..	123	118	68	12	11	..
	17	192	189	42	28	..	..	..	134	123	69	13	5	..
	22	139	135	30	30	..	..	..	132	126	40	16	..	..
	28	149	148	21	7	..	..	..	151	121	26	5	..	..
Feb.	1	169	160	20	..	..	..	..	150	100	10	..	..	..
	4	182	175	20	..	..	..	..	166	110	10	..	..	..
	8	186	160	21	..	..	..	..	176	116	9	..	..	..
			Tree E.							Tree D.				
Oct.	15										218	158	16	3
	17										56	28	4	2
	19										55	26	3	..
	23		leaves	marked							104	57	6	..
	26			140	140	55	9	..			87	36	6	2
	31			235	230	59	13	3			140	135	15	5
Nov.	4			200	106	60	12	1			101	90	7	8
	7			161	99	53	9	1			96	86	8	6
	10			102	81	43	10	1			90	80	7	5
	13			91	62	39	11	2			86	77	6	2
	16			92	61	40	10	2			81	69	9	..
	19			91	51	35	7	2			99	57	3	2
	22		shows	93	59	38	8	3		shows	93	58	8	..
	26		98	98	63	34	6	3		91	91	59	11	..
	30		100	100	76	38	6	8		116	93	36	23	..
Dec.	4		96	96	71	34	7	6		102	99	46	29	..
	11		192	190	186	62	13	8		190	180	81	39	..
	24		190	182	162	51	8	..	shows	146	122	68	21	..
Jan.	3	shows	186	91	81	47	8	..	157	157	96	56	11	..
	10	179	179	86	60	33	9	..	148	148	87	42	7	..
	17	168	168	57	40	21	6	..	129	124	68	51	3	..
	22	156	156	50	37	20	4	..	136	125	59	47	..	..
	28	186	186	59	27	5	2	..	198	180	44	20	2	..
Feb.	1	189	189	66	18	9	2	..	200	160	33	12	..	..
	4	200	190	77	15	8	3	..	205	160	32	11	3	..
	8	201	196	82	14	5	1	..	206	181	36	12	..	..

The growth of stems and roots, if an accurate enough record is kept, is found never to be steady, and the true explanation of its irregularity is probably analogous to that just given for the greater irregularity of the growth of the coconut leaves. In the stems and roots, the cells and tissues, having unequal inherent power to enlarge, as we know they have, set up tensions, the accumulation and release of which are expressed by the observable irregularities of rate. In roots there is also the opportunity for tensions between cap and body, in spite of the fact that the most rapid enlargement is often back of the cap. In the coconut, the entire elongating region is usually enclosed, and must inevitably stretch with more or less of a jerk every time the hold between the back part of the cap and the enclosed body is overcome.

The rate of growth is also conspicuously a function of the weather. As an illustration, a severe storm began October 31, and the growth during the four day interval following was slower in most cases than it had been immediately before. Again, there was some rain Feb. 5 and 6, and Feb. 8 and 9 were stormy. Vibar's table shows a slower growth during the four days, Feb. 4 to 8, than during the preceding three days. This is more clearly brought in Table III, containing the measurements of Lejano, of the youngest leaves only, of six trees.

TABLE III.

Growth per diem of youngest leaves, during the periods ending on the dates given. Beginning Jan. 28:

Tree.	*Jan.* 31	*Feb.* 2	*Feb.* 7	*Feb.* 9	*Feb.* 16
I....	30.7	32.2	26.5	15.5	22.3
II....	34.	32.5	31.4	22.	39.
III....	16.	18.5	25.	9.5	23.
Average..	26.9	27.	727.6	16.3	29.4
IV....	14.	25.	17.8	8.5	13.5
V....	19.	17.8	16.2	15.5	12.
VI....	32.	33.2	29.4	20.	25.3
Average..	21.3	25.3	21.1	14.7	16.9

It has already been noted that Lejano's trees are on very shallow soil, which had become decidedly dry by the end of January. The growth of his trees was slower at the beginning of February than during the preceding September; while the students whose trees grow on deeper soil found the growth in February more rapid than at any previous time.

It will probably be a cause of surprise to many, as it was at first to me, that a few days of rainy weather have a decided deterrent effect upon the growth. Most plants growing in the Philippines, whether herbs, vines, or trees, and in whatever étage, show this more markedly than does the coconut. Several hundred species, records of the growth of which are in my hands, have shown this whenever the records were so timed as to bring it out.

The difference between the diurnal and the nocturnal growth appeared as conspicuously as possible in my San Ramon work; for not merely was there frequently no growth at all during the day, but there was sometimes an actual shortening. Working here with adult trees, and at a time when the water supply for the roots was ample, the difference was still evident. It is shown by Table IV, compiled from the tables of Cevallos.

TABLE IV.

Growth of Leaves by Day and by Night. 3 Trees.
Bold-faced type, 5 p. m. to 5 a. m.

	Leaf.	1	2	3	1	2	3	1	2	3	1	2	3
Aug.	6..	0.0	10.3	0.9	0.2	13.0	0.8	0.5	18.5	5.0	1.4		
		1.0	**22.0**	**3.1**	**1.1**	**48.0**	**1.2**	**3.0**	**47.9**	**24.8**	**5.6**		
	7..	0.6	23.8	2.0	0.4	14.4	1.0	1.0	11.0	7.0	1.0		
		2.4	**41.0**	**6.2**	**0.9**	**41.6**	**3.0**	**3.2**	**52.0**	**18.0**	**4.0**		
	8..	0.0	4.0	1.5	0.3	11.0	0.5	0.9	13.2	2.1	0.6		
		0.5	**38.2**	**5.0**	**1.5**	**24.0**	**4.0**	**2.0**	**33.0**	**37.9**	**2.4**		
	9..	0.0	6.0	2.2	0.6	18.0	1.3	0.8	7.2	5.0	1.6		
		1.1	**27.0**	**4.5**	**4.0**	**54.0**	**5.1**	**1.0**	**29.0**	**32.0**	**4.0**		

All figures represent millimeters. The first column is growth in width; otherwise, all are increment in length.

The checking of the growth during the day is obviously a function of the decreased water supply of the crown of the tree. The same is true, at least in large part, of the damage done by drought. On the other hand, the checking of growth by prolonged rainy weather seems unintelligible, except as a result of the checking of photosynthesis. It is true that the temperature is usually lower during storms; but it is likewise true that February is a colder month than any from July to December, and yet it shows the most rapid growth except when dryness interferes. As a matter of fact, our differences in temperature from day to day, or from month to month are less than the usual difference between day and night, and the fact that the night is cold does not prevent rapid growth at that time.

Regarding the relation between the rate of growth and the age of the tree, it can be laid down as a general rule that from germination to maturity there is a gradual increase in the rate of growth of the most active leaves. The younger the tree, the slower the growth. This has been demonstrated on trees of various sizes; but as the exact ages of the trees are not known,it is not worth while to publish a tabulation of the measurements.

It has been emphasized, perhaps unnecessarily since it is necessarily so, that the measurements apply only to the visible leaves. When we state that the most rapid growth is shown by the youngest pisible leaf, it means that when a leaf appears it is at near the stage where the curve representing its grand period would reach the highest point. There are also present numerous invisible leaves, the most of which are very small and growing very slowly. Dissection of a young tree, whose free trunk was as yet only 50 cm. high, showed the following leaves which had not yet reached the light, but were well enough formed to be separated with a pocket knife and without the use of a lens. They are numbered from the largest to the smallest.

TABLE V.

Length of Concealed Leaves.

I	1.31 m.
II	0.43 m.
III	0.09 m.
	of which, 19 mm. sheath.
IV	50. mm.
V	34. mm.
	of which, 1.6 mm. sheath.
VI	21. mm.
VII	15. mm.
	of which, 0.7 mm. sheath.
VIII	13. mm. (?)
IX	11.2 mm.
X	8.7 mm.
XI	7.1 mm.
XII	5.5 mm.
XIII and XIV, separable, but too small to measure accurately.	

The rate of growth at different ages can be calculated approximately by the differences in length. It is evident that the growth in length is at first exceedingly slow, less even than 2 mm. a month, and increases until the leaf reaches the light.

In our coconuts, the interval between the appearance of successive leaves is usually more than one month; so that fully eighteen months can be expected to elapse before the smallest leaf-rudiment recognizable with the naked eye would grow into the light. Any condition which controls the rate of formation of these leaf-rudiments must therefore have more or less influence on the rate of the appearance of new leaves a year and a half later, and on the crops the tree can bear a year and a half later still. And this influence is a direct one. In the case of the coconut, as of any other perennial, unfavorable conditions, by lowering the general vitality of the tree, have indirect effects the duration of which is altogether indefinite.

The fact that leaves succeed each other at intervals of more than one month, indicates that our coconuts are not in very good condition; for at San Ramon, until the drought became too severe, the succession was considerably more rapid. In consideration hereof, it may be anticipated that better situated coconuts will under favorable conditions show a more rapid growth of the leaves than any we have been able to observe.

At the time these coconuts came into possession of the college, the grove was infested with cogon (lalang) where fire had run through it, and grown up with brush and small trees elsewhere. During the following year it was not cleaned, except immediately around the trees, with a bolo. After a thorough cleaning out, it was plowed shallowly during the first week of last September; the plowing reached at the most a depth of less than ten centimeters. As a result of the lack of previous cultivation, and of the shallowness of the soil, this plowing cut many of the roots. This was of course immediately injurious to the trees. The number of leaves on

them was at first from 21 to 27. During the succeeding two months, the majority of the plowed trees shed four leaves, while neighboring trees shed on the average less than two leaves. There was also an evident and immediate checking in the rate of growth of the younger leaves, from which the trees gradually recovered in the course of about three months. After this interval, the growth became more rapid than it had been before cultivation.

In spite of the temporary set-back it gives to trees hitherto neglected, there is no reasonable doubt as to the value of shallow cultivation. Six months after the act, it seems clear that our trees are more vigorous as a result of it. Surface plowing results in the development of a root system at a greater general depth; and assuming freedom from stagnant ground water this is an advantage, for it tends to secure immunity from drought. Moreover, some measure of surface cultivation is necessary for the controlled and rational use of fertilizers or of irrigation. The grove is now kept in decent condition by the occasional use of the disc harrow, at very slight expense, and without even temporary bad effect on the trees.

Effect of Fertilizers.

Half of the grove in charge of the class was fertilized September 9, each tree receiving 0.6 kilo of basic slag containing 20% P_2O_5, and 0.8 kilo of kainit containing 13.5% K_2O. These fertilizers were donated by Behn, Meyer and Company of Manila for this experiment. For reasons developed elsewhere in this paper, an application of fertilizer to the coconut is not likely to reach its maximum effect until at least eighteen months, and perhaps as much as three years after it is made. The fertilizer was scattered over ground already plowed, and was then harrowed in. It must first enter the plant in appreciable quantities, and this takes some time, before it can begin to have any influence. If it then hastens the building of leaf-rudiments, this effect can be seen only after a year and a half, or more; and the nuts borne in the axils of these leaves will not be ready to harvest within three years.

However, if the fertilizer is going to have much effect, this must appear more immediately in acceleration of the growth of the leaves. If it results in more rapidly growing and larger leaves, and so in increased photosynthesis and transpiration, the fertilizer is likely to have ultimate indirect influence on the production of nuts, more important perhaps than its direct effect can be. As a matter of fact, its influence on the growth of the leaves is already evident. During the first week in March, I have had measurements made of the growth of the leaves of all the normal trees under observation, fertilized and unfertilized. Trees attacked by beetles, and a few trees younger than the others, have been left out of account, for the sake of uniformity.

The following table shows some of the results of these measurements. The first part of it is compiled from measurements by M. B. Raymundo.

Table VI.

Average daily growth of leaves, fertilized trees:

Tree	Leaf 1	2	3	4	5	6
I	10.71	5.5	3.14	1.88	0.78	0.28
II	10.42	5.0	3.0	1.5	0.57	0.28
III	10.00	2.85	1.71	1.0	0.45	0.28
IV	10.28	6.14	broken			
V	8.42	3.28	1.71	0.88	0.36	0.14
VI	5.00	2.28	1.28	0.61	0.7	0.14
VII	7.07	1.21	0.44	0.11	0.04	0.00
Average	**8.84**	**3.74**	**1.88**	**1.00**	**0.41**	**0.19**
	Unfertilized trees.					
I	3.07	2.0	0.8	0.17	not	mea-
II	4.67	3.57	1.57	0.46	sured.	
III	3.64	2.17	0.6	0.04		
IV	5.35	3.71	2.21	0.71		
V	4.28	3.28	2.02	1.71		
VI	3.35	1.8	1.07	0.28		
VII	6.85	5.25	3.51	1.42		
Average	**4.47**	**3.12**	**1.69**	**0.68**		

Results of Cevallos, 6 trees each, fertilized and unfertilized

Fert.	**28.8**	**16.6**	**6.8**	**2.1**
Not Fert.	**26.6**	**15.8**	**3.7**	**1.6**

Lijano found the average growth of the youngest of his fertilized trees to be 27.9mm, and of the unfertilized trees, 20.8 mm.

Two general conclusions can be drawn from these determinations:

1. The average growth of all leaves of fertilized trees is greater than that of unfertilized trees.

2. The greater difference is to be noted in the older leaves. This indicates that the leaves of fertilized continue to grow for a longer time. This may have as much as the more rapid growth to do with the ultimate greater size of the leaves, and so the greater vigor of the tree.

The Spathe.

The growth of the spathe is a matter of general interest as a part of the general growth of the tree, and of especial interest to tuba producers, since the spathe is the source of their crop. The spathe ceases to elongate shortly before it splits open; this is usually from 75 to 90 days after the first

appearance of its tip. The total length of the visible part of the grown fertile branch is usually between seven and nine decimeters. The rate of growth of all spathes measured has risen at times to more than 2 centimeters a day; but the average, including periods of depression, and the final period of little or no elongation, is only half of the maximum. The curve, or rather the part of it we can get the data to plot, is quite irregular.

TUBA.

Partly for the sake of investigation partly to give practice, and in chief part because it is hoped that by using some of the trees for tuba, it will be possible to protect the entire grove against the attacks of beetles, a considerable number of trees have been operated on to produce tuba. It might be explained that this is the native name of the fresh or undistilled sap more widely known as toddy. As Mr. Gibbs, of the Bureau of Science, has in press a thorough study of this and other Philippine palm saps, I will here touch on only one point, and on this, the relative flow by day and by night, only because it seems to be in some dispute.

Table VI shows the flow from two spathes, as reported by Cevallos. Prior to February 10, the removal of slices from the bleeding tips was performed three times daily, morning, noon, and night; from this date on, it was performed only morning and evening. The extra slicing at noon would have a tendency to cause a more rapid flow during the day.

TABLE VII.

Tuba Production, Day and Night.

Night hours, bold-faced type.

Spathe.		1	2
February	5.....	123.0 cc.	56.0 cc.
		169.5	**101.0**
	6.....	175.0	124.0
		205	**132**
	7.....	235	112
		242	**171**
	8.....	225	135
		235	**206**
	9.....	210	185
		213	**174**
	10.....	240	150
		250	**240**
	11.....	167	160
		290	**260**
	12.....	175	125
		304	**209**
	13.....	115	185
		88	**210**
	14.....	130	125
		191	**162**
	15.....	117	117
		212	**124**

This production of tuba is less than would be obtained by any expert tuba gatherer, chiefly, I believe, because of the excessively thick slices removed by the students; but I cannot believe that there was anything in their manipulation which could cause any abnormal distribution through the day, of the sap. Further, a greater flow during the night is to be expected a priori, as a direct result of exactly the same factors which cause more rapid growth during the night.

CONCLUSIONS.

The most rapid observed growth of roots is at a rate of about 1.2 meters a year. If, therefore, the circle around each young tree, kept in good condition and devoted to the use of the coconut, have its radius extended at the rate of one meter a year, the tree will have as much ground as it can use. Only a few roots can grow farther.

The most rapid observed growth of the leaf is slightly over seven centimeters a day. This is likely to be exceeded by trees better situated, but is a fair standard of excellence. By making an allowance for the weather, if it is unfavorable, it is possible to estimate the state of thrift of a grove from a day's measurement of the growth of several trees.

The growth is checked by wind, by prolonged rain, and by drought severe enough to lessen the water the roots can absorb.

The growth of uncultivated trees is checked by surface cultivation; but this check is temporary, and is followed by a more enduring acceleration.

Within six months after the application of fertilizers, the effect can be seen in accelerated growth of the leaves. This is a practically sure promise of future increase of crop.

There are leaf-primordia large enough to be recognized with the naked eye, which will still require one and a half years in which to grow to the light; another year and a half must pass before fruit matures in their axils. Therefore, anything which can influence the rate of development of these youngest leaves will affect the crop three years later.

The growth of the leaves, and the production of tuba are more rapid during the night than during the day.

I am under obligation to S. Asunción, F. Cevallos, A. Lejano, A. Navarro, M. Raymundo, and T. Vibar, for careful execution of the field work forming the basis of this report.

OUR NEED OF PLANT DOCTORS

By Toribio N. Vibar.

The growing of crops involves no greater problem than the prevention of plant diseases and pests. As the area of cultivated crops is increased, this problem becomes more complex. Although disease and pest-causing organisms appear at one time more numerous and destructive, and at another time less so, they have already greatly increased in number; they are so wide spread; and their attacks have been so injurious, that plant doctors have become a necessity. Farmers found out first by experience or by chance preventive measures against the ravages of plant enemies. Later, plant pathologists, and economic entomologists were trained. They have been employed at the expense of the people to create better means of preventing and checking the causes of plant ailments; and men have thus become most successful in overthrowing plant maladies. Unfortunately, the number of plant doctors is too small, anywhere, for the numerous problems; and many plant doctors lay much stress on the studies of the life histories of plant enemies rather than on the demonstration of methods of prevention and cure.

In the Philippines, we have very few plant doctors employed by the government to solve our numerous plant disease problems. Because of the lack of many of them, our coffee industry has been pretty nearly wiped out; the uang and the coconut weevil are not exterminated; insects of the garden share a large part of our garden products, etc. Once the corn borer damaged more than 50% of the maize crop of the College of Agriculture. According to careful estimates insects alone destroy about $700,000,000 worth of plant product in the United States each year. We do not know of a similar estimate in the Philippines; but it is safe to state that at least 25%-30% of our plant products are destroyed by plant enemies. Many people do not realize the shrinkage of our crops in this manner.

Agriculture has already begun to receive more attention in these islands. The area of our cultivated native and introduced crops is gradually increased; and introduction of foreign crops receives great attention. The food supply of plant enemies is now plentiful, and will be more so. The organisms causing plant diseases will consequently increase in number. It has been found in the College of Agriculture that the raising of okra increased the number of *Dysdercus cingulatus*, and the growing of cucumbers increased the number of cucumber beetles. The growing of our agriculture is apparently accompanied by a multiplication of the plant enemies, the number of which increases directly with the number of crops raised. Unless they are kept in check, we can never hope to have the greatest return from our crops.

Some plants are more susceptible to disease than others, and some, although susceptible, can resist. All farmers know that this is the case. Those who do not know what remedy to employ in the prevailing diseases have but to give up the growing of the susceptible crops. But having plant doctors, the case will be different; farmers will be helped to know when, how, and what remedies are to be employed to stop the ravages of plant enemies. They, then, will not give up the growing of susceptible crops, but will be encouraged to continue to grow them with comparatively little fear of their destruction by pests.

Where there are farms near or adjacent to each other, cooperation among the farmers is an essential factor in agricultural improvement. It is impossible for a farmer to stop the ravages of plant enemies in his farm if his neighbors will not work to stop the same in theirs. The year before last, locusts appeared in Los Baños. At that

time the rice was near maturity and the farmers watched their crops with care. A band of them were seen by the writer driving the locusts from their plot, knowing well that the locusts would be in the other plots in a few minutes or hours. We asked them why did they do so, and the answer was "NEVER MIND! THE OTHERS CAN DRIVE THEM OUT OF THEIR PLOTS ALSO." The value of cooperation not being understood by many of our common farmers, and cooperation in the extermination of plant enemies being not well undertaken, our need of plant doctors is the greater.

In the Philippines we have two classes of agricultural doctors: Animal doctors, or veterinarians, and plant doctors or plant pathologists and economic entomologists. Much stress is being laid on the work of the former: laws and orders regarding the prevention of animal diseases have been formulated, and are now in effect. The Bureau of Agriculture has its veterinarians in many provinces. To the work of the latter, comparatively little attention is given: very few laws or orders have been issued on plant diseases. But if we take into consideration that most of our exports, the sole factor of our money wealth, are from plants,—not from animals,—we will give more attention to the eradication of plant diseases.

Many publications on the studies of the life histories and treatment of Philippine plant enemies have been issued, but issuing a publication does not guarantee that we can stop the ravages of the pests. Moreover, they are valueless to most of our common farmers for they do not read any paper. Should they receive notices, most of them can not read. There is only very little chance for them to obtain the interpretation. We urgently need enough plant doctors, who can be in contact with our common farmers, and can preach the gospel of better means of prevention and cure of plant diseases and pests, so that our farmers can understand and can fight their enemies with some chance of success.

It is true that our common farmers are often successful in checking the attacks of easily recognized plant enemies, but plants may die without apparent cause. When this happens it is a mystery to most of them. Should they find out the hidden cause it is like the discovery of a new world. Most of them do not know the life histories of plant enemies. They, therefore, do not know what is the best time or where is the best place to stop them effectively and economically. In order to be successful, a plant doctor must have a thorough knowledge of the diseases and of the treatment he should use. He should know what predisposition exposed the plant to disease, and the cause and effect thereof. He should know what conditions favor the rapid multiplication of the disease or pest causing organism, its life history, its habits, and its relation to the weather, food, and other factors of the environment. Very few of our farmers have any such knowledge. Without enough men recognizing them, and without enough able men to stop the ravages of plant enemies, our future agriculture will always find in them a difficult problem. Trained plant doctors we need and we will need. This is the time and the College of Agriculture is the place for their development.

REFORESTATION

FELIX FRANCO

Forestry is concerned in the production of wood crops. Therefore it is the duty of a forester to know the life history of the trees in the forest and all things pertaining to their growth and reproduction, and everything that affects their productiveness so that he can make the forest render its best service by producing the greatest quantity of material for construction purposes and for fuel.

The demand for Philippine hardwoods is steadily increasing, for many of our woods can not be excelled for beauty, strength, and durability. The Philippine forests, in a legal sense, cover an area of 40,000,000 hectares, but almost one half of this is waste land and grass land, while only about 6,000,000 hectares are cared for by the Bureau of Forestry. And it is from this area that the continual felling of marketable timber to supply the local demands and the material for export to the United States, China, and Europe is done. These fellings will soon leave the mountains partially covered with weeds only, thus increasing the waste land and grass land. It is supposed that all of this was formerly covered by valuable forests, and later cultivated with corn, rice, and other useful plants, though now entirely occupied by cogon and many of the useless parang trees. This abandonment of land once cultivated is due either to the lack of work animals, or to careless selection of land which the settlers are forced to leave after a year or two.

To have regular supplies of ripe trees all the time, we must look after the reproduction of the forest as soon as the mature trees are cut. No more forest areas must be turned into cogon and brush; and the barren hills we have must be permitted or helped to return to forest as soon as possible.

There are two ways of reproducing a forest;—natural and artificial. Natural regeneration is either from sprouts, or seeds which fall from the surrounding trees. Both are easy and inexpensive methods for no work on the part of man is required unless a better stand is wanted. Natural seeding depends entirely upon seed years. Besides, seeds that fall may be from worthless trees—true weeds that nature mixes with useful species. Trees growing high up on a slope may reproduce down the valley, but many of them have no means of spreading to considerably higher levels. Over natural reproduction man has little or no control. When the old crop is cut, buds of many trees develope into sprouts or shoots and these will grow into trees of small dimensions. This way of reproduction is known as coppicing or the coppice method. Natural reproduction can only be practiced in or near the forest. Artificial reproduction is also in two ways—sowing and planting. Both methods can be practiced in reforesting and planting the cogon areas which were once virgin forest. Sowing is usually practiced on rocky and steep places where it is difficult to work with tools.

Planting is preferable to sowing when it is practicable, for the seedlings which are transplanted from the nursery are more certain to live and may be rightly spaced to favor natural pruning. It is from such uniform stands as can be produced in this way that timber of the highest market value is taken.

Let us see how much reforestation has done for humanity. In France and other countries of Europe extensive areas of shifting sand dunes and sand hills have been converted into supply and protection forests which yield a constant revenue.

To reclaim our grass lands and turn them into promising forests, reforestation is necessary. The Bureau of Forestry is making a great effort to carry on this work. Nurseries where many species are grown, have been established, and thousands of seedlings will be transplanted onto these cogon lands in years to come.

In the second half of the senior year the students in the Forest School at Los Baños are required to have some practice in commercial forest planting and reforestation of cogon areas. During the last two weeks in October the Junior class of the Forest School reforested small tracts of cogon land on the Makiling Forest Reserve. About 4,000 seedlings of acle (*Albizzia* sp.), *balacat* (*Zizypus* sp.), *maluruhat* (*Eugenia* sp.) and other kinds were transplanted. On one of the peaks of Makiling mountain a large number of tree ferns and many stunted trees were cut down, and on the cleared area more than 800 pines (*Pinus sp.*) were planted.

Reforestation here must pass through an experimental stage before it can be practiced on any large scale. The College of Agriculture is well situated for this experimental work, which will certainly be carried on with vigor during the next few years.

LIVE-STOCK FARMING, AND SOILS

By Mariano Manas Cruz.

The study of soil management is of great importance, because of the fact that we are all directly or indirectly dependent upon the products of the soil. When these products are removed, they take with them the plant food which produced them. The main problem in soil management therefore is how best to maintain the productive capacity of the soil, and to increase such capacity for the production of farm crops.

The important types of soil management may be classified under three great systems of farming, namely: live-stock farming, where farmyard manure is applied to the land; grain and hay farming, where commercial fertilizers are used to supplement the manure; and what has been inaptly been called non-humus farming, where fertilizers are little used or not at all. The distribution of these various systems of farming in the United States has been largely the result of the adaptability of the soil and climate to certain crops; and of the use of the latter, which may be all sold for cash, or fed to stock on the farm. The system of live-stock farming is characteristic of the great corn, oat, and clover region of the Upper Mississippi Valley. The second, or grain and hay farming, is most generally practiced on the irrigated lands of the Far West. And the destructive third system is the one that is most commonly followed in those sections where the single-crop system yet prevails, as for instance in the cotton growing belt of the Gulf States.

The whole subject of soil management is indeed broad enough to fill a book by itself; but of the three systems of farming I consider the live-stock farming to be the one that most concerns our farmers in the Philippines as it is probably the cheapest way of so handling our soils as to make them more productive. I shall therefore limit myself to the discussion of this system. However, I am by no means of the opinion that other systems, especially involving thorough tillage, are without value in the improvement of the management of our soils.

It is claimed that frequent and appropriate cultivation of land, which is well drained and sufficiently provided with humus, will result in the production of maximum crops. However, such treatment would only give best results for a limited period of time. Hence, this practice of the thorough preparation and cultivation of the soil must be coupled with care in saving the manures from the farm animals to be applied to the land; thus returning much of the plant food removed by the crops.

At present we must admit that we in the Philippines are careless in disposing of our farmyard manures. The animals are pastured on any one field and our farmers do not trouble themselves to save their manures for use. Of course, such a method as this will result in the exhaustion of the fertility of the soil in other fields.

In the live-stock farming in the United States, the crops raised are practically all fed to the animals on the farm, and the resulting manure is carefully utilized. In case of a shortage of feed raised on the farm, some additional feed, as grain or hay, is purchased to complete the supply. When intelligently managed, this system invariably results in making the soil more productive.

To give a good illustration of the ultimate effect of manure upon the soil, I should mention that at the Louisiana Experiment Station it has been found during eleven years of experiments that a manured field produced from 388% to 475% increase over the yield from unmanured land.

The deterioration of manure results from two causes, namely: fermentation, whereby a certain amount of nitrogen is lost; and weathering or leaching, which involves a loss of the soluble fertilizing constituents, including potash and phosphoric acid as well as nitrogen. Through fermentation, manure undergoes a very rapid change especially if the temperature is high. The supply of moisture is a great factor in conserving the manure, for it lowers the temperature and thus retards fermentation. The supply of air also determines the successful rotting of manure. If the heap is too loosely built the decomposition is too rapid, hence the materials useful for the formation of humus in the soil are destroyed and the nitrogen, especially that of the urine, escapes into the

air, partly as ammonia and partly as free nitrogen. On the other hand, if the manure is too firmly packed the decomposition may be too slow and the manure will not become sufficiently disintegrated to produce the best effect on the soil.

As already stated, leaching is the second cause of deterioration of manure. This is usually observed in manure in which both the organic and the mineral constituents originally present have been made soluble by fermentation; thus, with the liquid in the manure, its most valuable constituents are carried off and lost.

The following table from Farmers' Bulletin No. 192 shows the composition and value of manure of different animals:

Source.	% Nitrogen.	% Phosphoric Acid.	% Potash.	Value per ton.
Sheep....	0.768	0.391	0.591	$3.30
Calves...	0.497	0.172	0.532	2.18
Hogs....	0.840	0.390	0.320	3.29
Cows....	0.426	0.290	0.440	2.02
Horses...	0.490	0.260	0.480	2.21
Hens....	0.8 to 2	0.50 to 2	0.8-0.90	7.07

As seen in the above table manure should contain 0.6% nitrogen, 0.3% phosphoric acid and 0.45% potash to be considered of fairly good quality. The loss of nitrogen and other constituents of manure by fermentation and leaching may be reduced to a minimum by the use of some litter or preservative. A good preservative is superphosphate, which, when mixed with barnyard manure and used upon potatoes, according to the experiments of J. R. Schiffer (as mentioned in Roberts' "The Fertility of the Land"), produced 247 bushels per acre, while there were only 232 bushels produced from an acre that was treated with manure unmixed with the preservative. Of course, the material used in this particular experiment has not only prevented the escape of ammonia from the manure, but also reinforced it in phosphoric acid which is deficient in it.

The best absorbents that are used in stables to take up the leaching liquids are peat, peat moss and straw for which Warrington claimed that they also furnish large amounts of fertilizing constituents. Saw dust on the other hand, has proven a poor absorbent, retaining little fertilizing matter and decomposing very slowly in the manure heap and in the soil. The use of saw dust can only then be recommended because of its availability and cheapness. In the Philippines we could use rice straw to best serve this purpose.

In the application of manure to the land, the physical properties of the soil must be taken into consideration in determining the rate, time, and depth of manuring which will give best results. In view of the fact that sandy soils have little power of absorbing and retaining the soluble fertilizing constituents of the manure, such soils are not heavily manured at any one time, but they are given small and frequent applications. The manure is applied to the soil only a short time before planting and is plowed to a greater depth than in the case of heavy soils. In clayey soils on the other hand, the manure is used in larger quantities with less frequent applications, and it is then worked into the soil a longer time before it could best be used for planting. The manure should be applied after it has been well rotted; otherwise it would increase the porosity of the land. This is especially undesirable in the case of sandy soils and in dry weather. It is usually applied at a rate of eight to ten tons per hectare of land and is evenly distributed. It must be properly worked into the soil in order to be most efficient. The spreading of manure is generally done by hand, but under favorable conditions a two-horse manure spreader is used for the sake of economy.

In conclusion, we can readily see that the care and use of farmyard manure are very essential to our farmers in the Philippines. Our water-buffaloes and pigs should be kept in pasture lots with small wallowing places. They would then spend much of the time grazing on dry land, and most of the manure would be dropped there, where it could be saved or plowed under after a time. In the latter case the pasture is changed to another place. Our horses and cattle should be kept in dry sheds on suitable beddings at night; and the manure kept under shelter and taken to the fields from time to time as it becomes well rotted. Then, finally, the poultry manure, which is the richest of all kinds should be carefully saved as completely as possible for use on the field. Thus, by the proper use of these different manures we could expect better yields from our farms, with relatively small expense and effort on the part of our farmers.

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AGRICULTURAL CONFERENCES

The Philippines more than any other country of the world need the aid of farmers' associations to bring up the standard of their agriculture to the level of that of most advanced countries. Every body is aware of this fact, and of late there has been a general movement for the establishment of leagues and associations.

The first Annual Agricultural Conference, under the auspices of the Bureau of Agriculture, was held at the Carnival City during the 1909 Carnival, with an attendance of some fifty or sixty delegates from different provinces of the islands. At the closing of the Conference an association, with the membership of all the delegates present, was formed. The organization proceeded with the election of a President and of a Vice-President for each of the several provinces represented. A Secretary was also elected. What the aim of that association was, is a question we can not elucidate. During the carnival of this year the same Bureau has given its Second Annual Conference. But the attendance this time was scarcely half as much as that of last year. There is an evidently dying enthusiasm on the part of the people.

During this same carnival, another conference was held at the Grand Opera House. This was entirely in the hands of private Filipinos. An association was also formed, and a Constitution adopted which provides for the appointment of lawyers "who shall take up such affairs of the Association as require the interference of the Courts." As is the case with most Philippine institutions of this epoch, this Association is more political than anything else.

Will the associations so far formed bring about the immediate prosperity that the Philippine farmer so badly needs? The craze for agricultural leagues has made everyone forget the appropiate aims of any such association, fostering the material development of its members, and of the Philippine farmer in general. The Agricultural Conferences given by the Bureau of Agriculture are rather instructive and are too academic for that purpose, while the Philippine Chamber of Agriculture is too political in its views.

Larger questions than the education of our farmers or the protection by law of their interests require immediate action on the part of some agricultural league. To take up a case, all or almost all the Philippine products are selling at too low a price. This is undoubtedly due to the lack of care with which the articles are handled here. Year after year the Philippines have been selling poor articles until they have gained the fame of sending the poorest product to the world's market. A position had at last been created that in many cases makes it utterly impossible for a single progressive farmer profitably to improve his products. This state of affairs must be changed, and can only be changed with the aid of the concerted action of agricultural associations.

There are many other questions of this kind that require the help of agricultural leagues, and their prompt attention.

THE CULTIVATION OF COCONUT*

By Manuel Roxas.

Twenty per cent of the Philippine exports in 1909 were coconut products, a fact that shows the extent of the coconut industry in these islands. Among the coconut growing countries of the world, the Philippines rank third, but the Philippine copra is poorest in quality. Our old method of drying and the common practice of using nuts not fully ripe, as well as lack of care in baling the products, are responsible for this low classification.

If we consider on the other hand, the thousands of hectares of our land, suited to coconut raising, remaining yet untouched, and the meaness of the effort the improvement of our copra will require, there is no evident reason why we should not make of the Philippines the first coconut producing country of the world, both as to the quality and quantity.

Supposing that we aim at this purpose, one of our first cares must be to stamp out all diseases that destroy our coconuts and reduce our profit. The *Uang* alone is causing a damage amounting in many localities to fully twenty per cent of the crop. In spite of this fact no effective measure has ever been taken by either our farmers or the Government to eliminate this pest. But we should eradicate it and others hardly less serious such as the red beetle and the bud rot, before we plant new tracts of land with coconut; for otherwise our new plantations will offer fresh breeding places for the pests, and thus aid in their propagation. Moreover, the labor which might be spent in planting new areas will render under present conditions no greater profit than it would if directed to the extirpation of the diseases mentioned.

In this paper it is intended to give some hints and criticisms for the improvement of our methods of cultivation, gathering of the crop, and the preparation of copra.

Selection of Seeds.

Little attention or none at all is commonly given the seed beds and the selection of seeds. Yet much is to be gained in the betterment of our nuts if we select the seeds and only plant those that are possessed of the characters suited to our purpose. For instance, when coconuts are raised for copra, big nuts rich in fatty contents are to be preferred, and if only seeds possessing those characters are planted, the next generation of trees will produce a greater percentage of such nuts, yielding on the average a better quality and larger quantity of copra. If on the other hand, tuba is the principal product, trees yielding the greatest number of fruits are more desirable, for more sap is obtained from them. Seeds from such trees are then used to produce seedlings. In selecting seed nuts, the characters of the trees from which they come are to be taken into consideration, instead of merely the character of the individual nuts.

But the great bulk of improvement will in most localities come from the importation of seeds from other places where nuts are of better quality. The coconut in La Laguna, for example, where copra is the principal product, may be greatly improved if this province imports seed nuts from S. Ramon, Mindanao. According to the census for 1904, from three hundred to three hundred fifty Laguna nuts are necessary to yield one picul (about 62 Kg.) of copra. About two hundred S. Ramon nuts yield the same amount. This great difference is due to the fact that nuts from S. Ramon are bigger and richer in fatty contents. Seed nuts from S. Ramon when carefully selected are worth from six to eight centavos each, placed in Manila. This price is almost twice that for local nuts. But the balance is far more than covered by the benefits derived from the use of big nuts with high fatty content. Even if it is supposed that the Laguna and the S. Ramon nuts are relatively equal in their fatty contents, still the latter will have the advantage of being bigger, which fact means economy in labor, since men here are generally paid according to the number of nuts they gather or handle in making copra. S. Ramon is not the only place in the Philippines that produces good big nuts. There are first-class nuts in Pangasinan and other nearby provinces.

Transplanting and Distance between Trees.

Seedlings are transplanted usually when they are from six to twenty-four months

*This article is the translation of a paper read in Spanish by the writer at the Agricultural Conference held during the Carnival of 1909.

old. The sooner the seedlings are transplanted, the better start they are given and the more healthy and productive the trees will be. The age at which to transplant is regulated by economic conditions.

The distance between trees depends upon the fertility of the soil. On rich soils the trees must be farther apart than on poor ones; for in the former trees are thriftier, and, therefore, occupy more space than in the latter. Coconut trees grow admirably in full sunshine when furnished with a good supply of moisture in the ground. Their rate of growth is in proportion to the amount of sunlight they receive and the quantity of water they can draw from the soil. If they are, therefore, so planted as to shade each other, they make poor growth. Economic conditions also regulate the distance between the trees.

The arrangement of the trees to be recommended is the *quincunx*. It has the advantages that every tree is equidistant from its neighbors, and there is an increase of eleven per cent over the number planted on a given area following the rectangular method. The *quincunx* is done as follows: a base line is laid out preferably parallel to one of the edges of the land. Divisions are marked on it, eight, nine or ten meters apart according to the space the trees are desired to have. These marks are used as centers, and with radii of the length of the desired distance segments of circles are drawn, the intersections of which determine the points at which to plant trees. The new points serve for finding others. The determination of the points and the digging of holes should be done several weeks before transplanting so as to weather the holes.

CARE OF THE PLANTATION.

Catch crops are generally used in the Philippines after transplanting. For this purpose, those plants that do not exhaust the soil too much are best used. Such are *palay*, *camoteng cahoy*—the roots of which contain a large amount of starch used for the production of tapioca—or mongo and other leguminous plants. Tobacco should never be used as it is a great nitrogen waster. Abaca grows faster at first than coconut, and when used for a catch crop covers the young trees in two years so as to make it hard for them to have a good growth. It is, though, used extensively for this purpose in La Laguna and elsewhere in the Philippines. Of course if the profit from it more than pays for the damage done the young trees, its use can not be discountenanced. But as a matter of fact the damage done is greater than can be compensated for by the value of the abaca since the former is permanent.

This treatment is continued for a period of from five to ten years, after which the plantation is left to itself and grass allowed to grow in it. This practice must be condemned, for the land will be best used for shade loving plants, such as *cacao*, *platano*, *piña* and others. The cultivation required by the catch crop will incidentally free the coconuts from competition with weeds, thus giving them greater chance to make good growth. Another practice is followed in the Straits Settlements, East Indies and elsewhere, where the land is turned into pasture. The cattle eat the grass and their excrement is scattered around the plantation and used as fertilizer.

FERTILIZERS.

The coconut makes good returns when fertilized; but in the Philippines fertilizing has never been done, at least on a commercial scale. According to Semler, the author of the *Tropische Agrikultur*, when a tree yielding forty fruits per year is fertilized with a good stable manure, it will increase its production to fifty, and another yielding eighty will increase it to one hundred during the same length of time. The value of fertilizers can be seen right here, and we recommend to our farmers the use of any kind available. In some places where coconut oil is made there are oil factories that extract the oil for nothing and make their profit with the oil cake, called *poonac* in India. They sell this at high prices, to be used either directly as fertilizer or as a concentrate for live-stock; in the second case the excrement of the animals is afterwards used as fertilizer. In these countries oil factories prove a success for the simple reason that they can dispose of their by-product as well as of the oil. The case in the Philippines is entirely different. So long as no application is given the oil cake, no oil factories can thrive well in these Islands. There are also commercial fertilizers sold by Behn Meyer & Co., Kerkhoven & Co. and others. The use of such fertilizers involves some expenditure of money, and we doubt if our farmers will use them on a large scale. But we are sure that they can be induced to use leguminous plants for such purposes.

These plants are nitrogen-fixers, better than ordinary manure as a provider of nitrogen.

In case stable manures are used as fertilizer, they are applied by broadcasting fifty cubic decimeters of the manure mixed with ashes, around each tree, and the ground hoed over. In Ceylon, cattle are fed grasses from the plantation, and their excrement is used as above described. Better results will be obtained if the animals are fed on leguminous forage crops planted in the coconut groves and their manure is left on the ground as a fertilizer. When commercial fertilizers are used the amount to be applied must be less and will depend upon their composition. The time of application as recommended by Semler is after transplanting on poor grounds, and before flowering on rich ones. The period during which their results show varies from three to six years.

ENEMIES.

The coconut has two principal insect enemies in the Philippines, the *Oryctes rhinoceros*, commonly called *uang*, and the *Rhynchophorus ferrugineus*, the red beetle, and also called *uang* by many. In the case of the former the adult insect does the damage, and in that of the latter the larvae. In the College of Agriculture we have seen the case of a tree attacked by the larvae of the *uang* (*Oryctes*), and the red beetle. The latter began the damage and when the tree had started to decay the Oryctes laid its eggs, and its larvae completed the destruction. The red beetle is far more dangerous than the Oryctes, for the latter's attack can be detected by the holes it makes and by the ragged appearance of the young leaves. But the symptoms of the attack by the red beetle are hard to see and tops of trees appearing healthy may suddenly be blown down by a strong wind. The cabbage of such trees is then seen to be rotten and full of pupae of the red beetle. The red beetle, on the other hand, never makes its holes on the old tissue of the tree to lay its eggs, but almost always takes advantage of those made by the Oryctes; or when the soft tissues around the bases of leaves are exposed, makes its hole there. It is therefore doubly necessary to suppress the Oryctes, thereby freeing our plantations of two most dangerous enemies.

The best remedy for these insects is to burn all decayed trees, and other decaying stuff, keeping the plantation in a good sanitary condition. Trees attacked beyond recovery must be cut down and burned. Wounds on trees must be filled with cement or other substance, preferably poisonous to the insect. The practice of the tuba-makers of making incisions on trees to facilitate climbing them, is a fruitful source of trouble and must, therefore, be condemned. The young tissues around the bases of leaves must not be exposed to the attack of the red beetle by taking away the fibrous stuff around them. By reducing the number of these insects, the damage done by them will be reduced. Preventive measures are always the best.

There also exists in these islands the Bud rot, or the rotting of the cabbage, due probably to bacteria. This disease is highly infectious. Its symptoms, propagation, the method of combatting, and the history of its appearance in the province of La Laguna, are all described in a paper of Dr. E. B. Copeland, now Dean of our College, published in May 1908 in the Philippine Agricultural Review.

GATHERING OF NUTS.

The low quality of our copra is due mainly to the use of immature nuts, and to the poor method of handling it. The common nut-gatherers never allow the nuts to mature completely. Much is to be gained if, instead of gathering the nuts while on the tree, they are allowed to be dead ripe, and to ball of themselves. They will be thus given time to concentrate their oil contents, and thus yield a better quality of copra. This method has two objections: one is the chance for the fruit to germinate on the tree before falling, and the other is the danger of the nuts' being lost, or destroyed, after falling. The first difficulty in localities where it occurs, can be avoided through seed selection; the second is easily remedied by keeping the plantation free from weeds. This practice may seem costly, but if we know how to relate it with others it will result economically. Letting the ripe nuts fall will suppress the bad habit of the majority of the nut-gatherers of making incisions on trees to aid in climbing.

COCONUT PRODUCTS.

The principal coconut product exported from the Philippines is copra. The total export of this article for nine months ending March, 1909, was 5,353,548 dollars, of which 2,774,131 dollars, representing 122,638,576 pounds of the article, that is more than one half of the export, were

imported by France alone, (from the "Quarterly Summary of Commerce of the Philippine Islands" for January-March, 1909.) But the Philippine copra is classed as the poorest, as can be seen from the following prices of copra from different countries, in Marseilles, Dec. 11, 1909:

For every 100 Kg.

Ceylon sundried	61	Fr.
Singapore	58	,,
Macassar	57	,,
Manille	55	,,
Zanzibar	56.50	,,
Java sundried	60	,,
Saigon	56	,,
Cotonon	56.50	,,
Pacific Samoa	57	,,
Oceanie Francaise	57	,,
Mozambique	58	,,

(From L'Agriculture Pratique des Pays Chauds).

One franc is worth about thirty eight centavos.

Comparing the price given for the Manila copra with that of Ceylon sundried, the former is losing eleven per cent by this difference in classification. If we could therefore, improve our copra and succeed in classifying it among the best, we would increase our income eleven per cent for this product. According to Prudhomme the superiority of the best copra is "to be mainly attributed to a very careful preparation and to the use of well matured nuts."

Sun drying versus kiln drying. As has been pointed out in the beginning of this paper, the low price given for Manila copra is mainly due to an imperfect method of drying and to the use of immature nuts. It is worth while to quote Prudhomme when speaking of the different investigations on the effect of drying on the quality of the oil obtained: "One can, I think, draw from these investigations the following conclusions.

"1.—The oils of the most pure and of the best quality are extracted from little colored copra that proceeds from well matured nuts.

"2.—Drying by smoking and kiln drying, when poorly done, have the great inconvenience of yielding copra of a more or less dark color, giving out a well pronounced smoky odor, and leaving as residue a cake of inferior quality.

"3.—Sun drying gives the most excellent results when well conducted.

"4.—The finest copra can only be prepared from perfectly mature nuts."

There are several ways of drying copra: kiln drying, smoking in "smoke houses," and by means of the sun. Stoves are also used.

In rainy countries where sundrying can not be relied upon and where farmers can not afford to expend money for stoves, kiln drying can be resorted to, but fuel giving out the least amount of smoke must be used.

The desiccated coconut is a product largely consumed the world over, but not produced as yet in the Philippines. This article is used in making pudding and sweet-meats. 7,900,000 Kg. of this product was exported from Ceylon in 1903.

The industrial preparation of desiccated coconut involves several steps: splitting of nuts and separation of meat from shell; the rasping of the meat to reduce it to small fragments; the desiccation and the baling of the product.

The meat after being reduced to a pulpy mass, is put in a hot air stove, where it is kept at a temperature of 80° to 88° Centigrade. From this chamber the desiccated coconut is allowed to cool on wooden tables. Then it is cased in packages made from thin sheets of lead very similar to tea packages, and is sold in that form. Packages containing one-half, one, two, and three pounds of the product are prepared. Three average sized nuts yield a pound of desiccated meat. 6,700 nuts are necessary to produce one ton. (From Prudhomme Le Cocotier.)

The coconut oil is a product largely consumed at home. But perhaps for that same reason no effort is made to make it better. The factory of the Philippine Products Company, the first of its kind in the Philippines, run by Americans in Pandacan, exported in 1908 to the United States and to England 709,239 gallons of oil, valued at 265,069 pesos, and which were made from 5,325 tons of copra (Report of the Collector of Customs for 1908). Although this oil factory could not dispose of its by-product here and had to export a part, yet it thrived fairly well. Through internal troubles the company closed its business after the factory was accidentally burnt. The Philippine Products Co. would have gained a great deal more if it could have disposed of its by-product locally. It is important that we create a market for our factory by-products, if factories of any kind are to have a *complete* success.

THE CONFERENCES OF THE BUREAU OF AGRICUTURE

The agricultural conferences under the auspices of the Bureau of Agriculture took place in the first part of the Carnival week.

We have not tried to reproduce the lectures, the size of our paper not allowing us to do so; but merely to sketch what facts are likely to be of interest to our readers. The conferences were to open on February 21st, but unfortunately there was no quorum at the fixed time, so that the opening was delayed till the next day. The musical program and some speeches were entirely eliminated.

The sessions began with an address by Hon. Mónico R. Mercado, Chairman of the Committee on Agriculture of the Philippine Assembly. He discussed the evils affecting our agriculture, dividing them into three classes: first, evils which can be remedied by the farmers individually, as the question between laborers and their patrons; second, evils which can be remedied by the union of the *hacenderos*, as the fixing of the price of their produce so as to avoid the mercenary clutches of the Chinese buyer; and third, evils involving great sums of money for their remedy, which can only be undertaken by the government.

The scientific program then began, and Mr. M. M. Saleeby lectured on "Present Condition of the Abaca Industry in the Philippines."

He denies the truth of the general statement that the expenses in the cultivation of abaca are more than the income, but he imputes its origin to the fact that three or four years ago the price of abaca rose to ₱28.00 per picul. This, of course, stimulated farmers to increase their yield, and they planted abaca wherever there was land available. When the good days passed, the plants grown on poor soil did not produce enough to profit; hence the discouragement of many planters.

"Abaca needs an abundant rainfall distributed throughout the year. A bad effect is noticed after three weeks without rainfall, and if this continues for another week the leaves begin to fall.

"Valleys and banks of rivers, which overflow, are observed to furnish the ideal soil for hemp; loamy soil where there is a current of water are second best; and regular soils, with clay and loam, grow pretty good plants.

"The varieties of hemp differ from each other in the quality and quantity of fibre produced. *Samarong puti* and *Samarong pula* are the best varieties; they produce fine and white fibre.

"In Albay are found the best varieties, Leyte has good ones. Davao has many varieties but most of them are coarse. The production of hemp in Davao is from 20 to 25 piculs per hectare, while in Albay, Camarines, and Leyte, it is only about 7 piculs per hectare."

Discussion.—A man from Albay believes that the price of abaca does not depend upon the production of the plant, but on the way it is stripped.

Delegate from Cavite * * * "Why did the price of abaca lower?" The lecturer answered that the price of hemp was abnormal a few years ago and that it lowered due to the entrance of many kinds of fibres into the market, but still it holds the highest price. Perhaps, it is the best benefited except sisal. The low price can not be remedied by the government, but by the planters themselves by producing better grades of fibre. Sisal is only as good as low grade abaca, so that if the best grades of hemp are produced there will be no market for sisal.

TOBACCO.

The lectures on this subject were delivered by Mr. R. W. Rowe and Mr. H. M. Wagenblass.

"The Cagayan Valley is the section best adapted to the growing of tobacco in the Islands. Twenty miles up the Cagayan River is not a very good place for tobacco, the plants being exposed to the breezes of the sea; the chlorine in the sea air renders the leaves bad-burning.

"The Cagayan Valley may be divided into three sections. The most fertile part, which furnishes the best growth, is that which is overflowed by the river every year. Second class, is that overflowed every two or three years; this is planted with tobacco once in a while and then allowed to rest. Third class includes mountains which are not fitted to the cultivation of tobacco.

"The tobacco crop in the Cagayan Valley is sorted into three classes: for cigars, for cigarettes, and for export. The best grade is for home use and cigars, while the poorest is for export.

"Isabela produces the best quality; it has not only fertile soil, but also it is un-

affected by the sea air. In the Visayan islands tobacco is produced for quantity, while in the Cagayan valley, for quality.

"Fifteen or sixteen varieties are found many times in a field, and as a consequence there is no uniformity of the leaves in the market. In selecting seeds for the next planting the seeds from the main blossom should be saved and all other seed heads should be cut. When there are enough seed heads preserved, the tops of all other plants should be cut to allow the leaves to obtain the full nourishment. The seeds are picked when ripe brown and stored in dry bottles.

"In the selection of leaves the size of the blade, the size of the veins, the internodes between leaves, and the distance between the ground and the leaves are taken into account.

"The present mode of curing the leaves is very imperfect. They are cured in the sun from three days to three weeks. The sun often dries them instead of curing them."

CAMPAIGN ON RINDERPEST.

In the absence of the Chief Veterinarian of the Bureau the assistant chief, Ralph F. Knight, lectures on the above subject.

He classified the diseases affecting animals as contagious and non-contagious. "Non-contagious diseases are single cases, as peritonitis and indigestion, but contagious are plagues, as rinderpest.

"Rinderpest may be transmitted from one animal to another by direct contact, or by having animals pastured in the same field where diseased animals were. In this way it may be carried through the nose, throat, or feet.

"The surest measure in eradicating pests is immediate destruction by killing the diseased animal instantly, and part of the cost of the animal should be refunded by the government. But since the legislature does not see do this fit, other methods have to be used; strict quarantine is the only available method. In extreme cases complete isolation of individual animals should be practiced. Infection of a field may be removed in one month in case it is dry, otherwise it takes a much longer time."

He then described the rinderpest infection in Miagao, Iloilo, where strict quarantine had no effect, except to restrict the disease to the town. When for several months the disease did not disappear severe measures were taken and each animal was tied with a short rope so as not to be in the way of any other. Only through this method the disease was completely eradicated.

"During the months of quarantine and isolation the farmers and merchants complained. Indeed, labor in the farm was delayed and commerce stopped, but in the long run they were benefitted for the loss of a single animal means several days' work.

The sessions ended with an address by Mr. Agcaoili who spoke on "Agricultural Associations," and with the election of officers of the Philippine Agricultural Association. There were other lectures given, but we are sorry to have missed them.

The number of delegates this year was not half as much as that of last. We believe that this lacking of enthusiasm is due to the fact that too broad questions are taken up. A farmer does not take much interest in knowing how much sugar is produced by his country, nor how it is done, for he himself does it as any of his brothers in the other localities, more or less. These data would be useful to statisticians, economists, scientists, or legislators. Supposing the crop is not grown in his province, you can not by a talk move the farmer to grow it. Wherever a farmer goes, goes his home and money, and these do not move at a snap.

Questions as to the better use of the plow, the harrow, and other general tools; practical facts on selection of seeds, methods of planting and cultivating, on the water relations of the plants, and preparation for market, will appeal more to him. Methods of eradicating diseases attacking plants will be of use to him.

In late years the question of fertilizers has occupied the mind of the Filipino farmers. They have been shown by merchants the benefits of fertilizing, but they forget that different plants need fertilizers of different quantities and kind, many times. This is a question on which our *hacenderos* seek information.

Simple and practical facts are what are most appreciated by our farmers.

B. M. G.